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Diseases and Insects of Small Fruits

C. R. Crosby, W. H. Rankin, and W. D. Mills



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DISEASES AND INSECTS OF SMALL FRUITS

C. R. CROSBY, W. H. RANKIN, AND W. D. MILLS

The purpose of this bulletin is to give growers of small fruits the latest information available on the control of the diseases and insects affecting these crops. Much of this material has been published elsewhere but is not readily available to growers. Considerable additional information has been obtained from unpublished data of the research workers of the state experiment stations.

Hugh Glasgow, F. Z. Hartzell, and F. E. Gladwin of the New York State Agricultural Experiment Station at Geneva, New York, have been especially helpful in furnishing information and in making suggestions as to the best methods of control. Many valuable suggestions have also been received from the county agricultural agents in those counties where the growing of small fruits is an important enterprise.

CANE FRUITS

Raspberries and blackberries are both subject to crown gall, anthracnose, rust, and leaf-spot. Raspberries are also subject to the following diseases: wilt, powdery mildew, spur-blight, the mosaics, leaf-curl, and streak. The most serious insect pest of raspberries is the fruit worm; and the leaf-miner is sometimes serious on dewberries. The cane-borers often attract attention but are not likely to cause serious loss.

MOSAIC DISEASES

(Caused by viruses)

The two mosaic diseases of raspberries are so important that every grower should consider their control as a necessary part of his cultural practices for maintaining vigor and yields. The symptoms by which a diseased plant may be identified differ according to the kind and variety, and the seasonal conditions. In general, the mosaic diseases cause changes in the leaves, which result in light-green or yellowish green, large or small, indefinite spots. Also the leaves may be misshapen, blistered, and dwarfed in size. The new canes do not grow so tall in most varieties and are more slender. The leaves of the fruiting shoots in early spring and the first leaves on the new canes when they are from one to two feet tall show the most pronounced yellowing. In black varieties, besides the leaf symptoms the new canes may die back at the tips. A more complete description of symp-

toms will be found in *Virus Diseases of Black Raspberries*, by W. Howard Rankin (New York State [Geneva] Agricultural Experiment Station Technical bul. 175. 1931) and also in *Raspberry Growing in New York State: Cultural Practises and Disease Control*, by George W. Slate and W. Howard Rankin (Bulletin 625 of the same Station, 1933).

Direct losses caused by the mosaic diseases are due to the shortened length of the profitable life of a planting, the diminishing stand of healthy plants, reduced yields of fruit per acre, and the poor quality of the fruit from diseased plants.

The principal hazard in mosaic control is the local rate of spread. Rate of spread depends largely on the abundance and movement of the aphids that carry the mosaic from diseased to healthy plants.

Control in central and western New York

In this region the mosaic-carrier aphid is usually not present in large numbers and therefore mosaic control is not difficult. There are three necessary steps, each of equal importance, that a grower should take to reduce mosaic losses.

First, the stock used to make the new planting must be practically free from diseased plants. There is no means of knowing whether the stock is free from mosaic except to know the conditions of the summer before, in the planting from which the stock was dug. Stock from rogued fields showing less than two per cent of mosaic is as free as can usually be expected.

The second step in reducing rate of spread of the mosaics is to choose carefully a location for the new planting as far distant as possible from diseased raspberries; 300 to 400 feet is necessary and greater distances highly desirable. Wild raspberries are often diseased and should be destroyed for distances of several hundred feet around the planting.

The third step is to go through the planting during the first and the second year after planting, at least once each month when leaves are on the plants and remove immediately any diseased plants that show mosaic symptoms. The entire root system of these plants must be dug, and care taken not to shake off any aphids on the plant while it is being dug and carried out of the planting. Scorching the foliage with a blow torch or weed burner to prevent the spread of aphids is an excellent precaution before digging a diseased plant.

If the above three steps are taken, the planting should enter its third season practically free of mosaic and usually no further measures of control are advised, although a grower may continue to take out diseased plants if he considers it worth while. One cannot expect a planting to remain free of mosaic indefinitely, and must accept the accumulative losses in vigor and yield as the planting becomes older.

The mosaics spread more rapidly in some varieties than in others. All black varieties are subject to rapid spread and must be placed as far distant from all other kinds as is possible. One of the best black varieties, Cumberland, is difficult to keep free from mosaic but its resistance makes it a desirable variety to grow. It is injured less than other varieties and the diseased bushes will turn off a fair crop for a period of two or three years after they become affected. Mosaics do not spread very rapidly in Cuthbert and June, and these varieties can be grown successfully if rigid precautions are taken. Latham can be grown without any precautions to control mosaic because its resistance is sufficient to maintain fair vigor and yields. The new red variety, Newburgh, escapes mosaic infection sufficiently to allow growing without much attention to isolation from other raspberries.

Control in the Hudson Valley

In some sections of the Hudson Valley, particularly the central section between Kingston and Newburgh, the aphids that spread the mosaics are often abundant and rapid spread of mosaic is the result. Mosaic-free stock, isolation, and removing diseased plants, are not practical in this region. Control must be sought by the use of varieties that are resistant or those that escape heavy infection. No black varieties are known that would be successful under such conditions. The red variety Latham is the most successful variety and although all plants in most plantings are affected by mosaic, excellent vigor is maintained in well-managed plantings. The other standard varieties are too susceptible to be grown where spread is so rapid. The new red varieties, Chief, supposed to be resistant, and the Newburgh, which escapes infection, are being tested but are not recommended until their behavior is better known.

LEAF CURL

(Caused by a virus)

This disease often occurs in plantings of the red variety Cuthbert. The leaves are dark green, crinkled, and rolled downward at the margins. The canes are severely dwarfed.

In early spring all affected plants should be dug up and burned. It spreads very rapidly if not removed soon after growth starts.

STREAK

(Caused by viruses)

Two streak diseases are serious in black raspberries. Mild streak occurs commonly in some sections of New York. Severe streak is not often found. The first signs of mild streak in a plant are difficult to find. The canes are

not dwarfed and the leaves are, at most, slightly cupped. The lower parts of the new canes often show short bluish streaks under the white bloom. The berries borne on such plants are drier and show more bloom and thus are gray rather than black at picking time.

The principal control measures are to obtain planting stock from fields free of streak and to avoid locations with wild or cultivated black raspberries or blackberries nearby.

RASPBERRY FRUIT-WORM

(*Byturus unicolor* Say)

The raspberry fruit-worm, or American raspberry beetle as it is sometimes called, is widely distributed thruout the Northern United States and Canada. Although it attacks black and purple raspberries, it is most injurious to red raspberries, especially to early varieties. Recently it has become a serious pest on loganberries in the Northwest.

The beetle is about $1\frac{1}{7}$ inch in length, light brown in color and slightly hairy. The beetles appear on the plants in May as the new foliage is unfolding and feed on the buds and tender leaves, later attacking the blossoms themselves. The leaves become riddled with holes and often the blossoms are so badly injured that the crop is practically destroyed.

The beetles deposit their whitish oval eggs on the green berries, on the blossom stems and leaf petioles, usually so well hidden among the plant hairs that it is difficult to detect them. On hatching, the young grubs enter the blossom buds or young fruits where they feed on the fleshy receptacle. Some of the infested fruits dry up before ripening, others decay, and many others at picking time contain a larva lying between the berry and the receptacle. Many of these larvae are gathered with the berries and are overlooked until the fruit is served. The full-grown larva is about $\frac{1}{4}$ inch in length, yellowish white in color and sparsely clothed with transverse rows of stiff, light-colored hairs. When mature the larvae fall to the ground where just below the surface they construct earthen cells in which to pupate. In some years at least part of the grubs reach the adult stage before the advent of winter but the beetles remain in the pupal cells until the following spring.

Control

Thorough but shallow cultivation of the soil during late summer and early fall as close to the plants as practicable will break many of the pupal cells and reduce the number of beetles emerging the following spring.

The damage caused by the raspberry beetle is of two kinds; destruction of the buds by the beetles and the loss resulting from the presence of the larvae in the berries. Prevention of both kinds of injury is difficult because the plants are likely to be injured by too many applications of spray.

The presence of the larvae of the raspberry beetle in the berries may be largely prevented by spraying with 4 pounds of lead arsenate, and either 1 pound of casein spreader or 1 pound of powdered skim milk, in 100 gallons of water. The first application should be made about 10 days before the beginning of blossoming; the second just as the first blossoms begin to open.

To protect the buds from destruction by the beetles it would be necessary to start spraying much earlier than indicated above. The first application should be made soon after the beetles appear and begin feeding on the foliage. A second application should be made in about 10 days. It is not usually possible to make more than three spray applications without injury to the plants and sometimes two is all that can be made with safety. In heavy infestations the plants may not be able to stand enough applications to protect the buds from the beetles and also to prevent the presence of the larvae in the berries. The grower, therefore, should decide whether it is more important to obtain a large early crop by protecting the buds or to have the berries free from worms and to plan his spray schedule accordingly.

RED-SPIDER

(*Tetranychus telarius* Linnaeus)

The red-spider is discussed on page 13 as a strawberry pest. On raspberries these mites often cause important injury, especially in hot, dry seasons. The mites are found on the under side of the leaves where their feeding causes the foliage to turn yellowish brown and, in severe cases, to dry up and fall off. The size of the crop is decreased and the quality of the fruit impaired. When abundant, the mites may swarm onto the berries in countless numbers at picking time. Their presence on the fruit in the market is objectionable.

Recent experiments indicate that good control of the red-spider on raspberries can be obtained by spraying with 1 gallon of summer or white oil in 100 gallons of water. The material must be applied with high pressure and the spray directed upward so as to hit and wet the mites on the underside of the leaves.

WILT

(Caused by *Verticillium alboatrum* McA.)

Wilt is a disease that may occur in new plantings of black or red raspberries, if the wilt fungus is present in the soil. Crops preceding the raspberries, such as tomatoes, potatoes, eggplant, and others of this group, may infest the soil with the wilt fungus. If only a small amount of wilt shows in the new raspberry planting it need not be assumed that it will be a

failure, for usually the trouble disappears rapidly and affected plants may recover. A broad blue stripe usually develops on the side of the new canes and the leaves are shed from the base upward. Such canes usually die.

POWDERY MILDEW

(Caused by *Sphaerotheca humuli* (Fr.) Burr)

Powdery mildew occasionally occurs in red raspberries. It first becomes apparent on the tips of the new canes after they have reached a height of 2 or 3 feet. The tip leaves are dwarfed in size, mottled, and distorted resembling in many respects red mosaic. The under surface of the leaves shows a water-soaked appearance or a white coating which serves to identify it as powdery mildew. The tips make a sharp spike-like growth of a few inches in severe cases and then are permanently halted in growth. The Latham variety is often affected by this disease. Observation indicates that this disease is not likely to occur in New York if the planting is situated so that the air circulates freely on all sides. There are no direct control measures and a heavy infection one year may be followed by complete absence the next.

PURPLE CANE SPOT

(Caused by *Mycosphaerella rubina* (Pk.) Jacz.)

The purple-cane-spot disease is very common ailment of raspberries. The spots are large and are conspicuous on the green canes by early autumn. The disease is also called *spur blight* because the buds are killed where the spots occur and no fruiting laterals are formed the next spring. These spots on the canes are less injurious to the general health of the cane than they appear to be.

Control: Clean culture, narrow rows, proper spacing of canes by thinning, and locations favorable for good air drainage give practical control of this disease. If the grower fails to provide these conditions, spraying the new canes in late spring with bordeaux 4-6-50 and a sticker may be necessary to hold the disease in check. Two applications are advised, the first when the new canes have reached a height of about one foot and the second two weeks later. Care should be taken to direct these sprays at the new canes only, since injury often results from either bordeaux or sulfur mixtures if applied to the fruiting cane foliage.

RASPBERRY CANE-BORER

(*Oberea bimaculata* Olivier)

The adult is a small long-horned beetle, black with the prothorax yellow. The beetles appear in June and the female deposits her eggs singly in the

pith of the new growth about 6 inches from the tip of the cane. She first makes two rows of punctures around the cane about half an inch apart and inserts her egg near the lower row. This girdling causes the top to wilt. The egg hatches early in July and the larva burrows slowly towards the base of the cane, passing the winter within an inch or two of the girdle. The second season it continues its burrow through what is then the bearing cane and usually kills it before the fruit matures. The second winter is spent in the cane near the ground. The beetle emerges the following spring.

Control

The wilted tips are easily seen. They should be cut off below the lower girdle and destroyed. Since the insect breeds in wild raspberry plants they should not be permitted to grow near commercial plantings.

RED-NECKED CANE-BORER

(*Agilus ruficollis* Fabricius)

Irregular swellings, or galls, one to three inches in length on the new canes of blackberry, dewberry, and raspberry indicate the presence of this borer. The adult is a small beetle about $1/3$ inch in length; the wing covers are black, the thorax coppery, and the head black. The beetles are active during June and July. The female deposits her eggs singly in the bark near the base of a leaf on the new growth. The young larva first burrows in the sap wood spirally around the stem two to six times, thus girdling the cane and causing the gall to develop. It then enters the pith where it passes the winter in a partly grown condition. The next spring it completes its growth and the transformation to the beetle takes place from late May till July. There is only one generation a year.

Control

This pest may be controlled by cutting out and burning all infested canes during the dormant period of the plants. This work can be done best while pruning the bushes. All wild or neglected berry bushes near commercial plantings should be destroyed.

BLACKBERRY LEAF-MINER

(*Metallus rubi* Forbes)

Near Lake Erie blackberries are subject to attack by a sawfly leaf-miner. The injury to the foliage from heavy infestations weakens the plants and causes poorly developed fruits of inferior quality. In this region many plantings have been abandoned because they became too weak to produce profitable crops.

The adult sawfly is nearly black and about 1/6 inch in length. Two broods of adults appear each season; the first in late May or early June, the second in late August. The female sawfly inserts her eggs singly in the tissue of the leaf. The eggs of the first brood hatch in about two weeks. The larva feeds between the two layers of the leaf excavating a rather large blotched mine; three or four mines may occur in a single leaf. The injured part of the leaf turns brown and dies; in severe cases the whole field has the appearance of having been singed by fire. When full-grown, the larvae abandon the leaves and enter the ground for pupation. The injury caused by the second brood becomes evident in late August and September.

Control

No satisfactory method of control for the blackberry leaf-miner has been devised. About half of the larvae can be killed in the mines by spraying with a 4-per-cent emulsion of high-grade summer oil. The application should be made soon after the mines become the size of a five-cent piece.

CROWN GALL

(Caused by *Bacterium tumefaciens* E. F. Smith and Townsend)

Crown gall occurs commonly in brambles but rarely causes serious injury in New York.

Red varieties of raspberries are particularly free from injury by the gall in this State. Crown gall is more serious in purple and black raspberries and in blackberries in the cases where it is prevalent.

This disease is serious only when galls appear on the canes at the ground level or higher. The galls in red varieties are confined to the crown or the roots and rarely appear above ground. They may be very small swellings or large tan-colored lumps roughened with nodules on the surface and loosely attached to the roots. In black and purple varieties the galls may occur on the over-wintering canes as tan-colored, rough, swollen areas breaking through the dark-colored bark. The microbe which causes this disease lives over in the soil.

Control

Do not plant brambles on soil known to have grown plants showing these galls until several years have elapsed.

New stock should not be accepted if showing a considerable number of galled plants. All stock should be carefully examined at planting time and plants with galls discarded.

ANTHRACNOSE

(Caused by *Gloeosporium venetum* Speg.)

Anthracnose, also called *the cane-spot disease*, frequently causes injury to black and purple raspberries and to blackberries. This disease becomes serious when frequent rains in the spring result in a heavy infection of the lower parts of the new green canes. At each purple spot, with its gray center, green bark is destroyed and when the spots are numerous the cane is girdled. Dwarfing and even death of the new canes may occur. The fungus may also spread to the fruiting laterals and to the blossom stems and leaves, causing the fruit to dry up before ripening. Thus a heavy infection may cause the loss of two seasons' crop.

Control

This disease is largely controlled by modifying the cultural practices. The grower should avoid bringing the fungus into the new planting. Rooted tips for the new planting should be dug and planted while they are completely dormant. Leaving the rooted tips attached to the canes in the fruiting block until new canes are sent up is a very poor practice. In addition to planting dormant roots, the handle should be cut off from the set. Leaving the handle attached allows the fungus to spread in the new planting from any cane spots that may be on it. In addition to these precautions, rigid clean culture will assist in keeping the cane-spot disease under control by allowing quick drying of the canes after rains. In fruiting blocks in which this disease has obtained a foothold, one application of lime-sulfur, 1-10, applied at the time the new leaves are just appearing on the old canes will give some measure of control. No later applications of any fungicide are advisable because of likely injury to the fruiting cane foliage.

ORANGE RUST

(Caused by *Gymnoconia interstitialis* (Schl.) Lag.)

This disease is serious in black raspberries and in blackberries. It causes a complete loss of crop on the diseased plants. The first leaves appearing in the spring are yellowish on the under side. A little later the yellowish blisters break, spreading the bright yellow-orange spores of the rust fungus.

Control

The affected plants should be dug up and burned before the orange spores are released from the blisters, since they are the means of spreading the disease.

LEAF SPOT

(Caused by *Septoria rubi* Westd.)

The common small purple spots on the leaves of all brambles are caused by the leaf-spot fungus. Although conspicuous, this disease is only serious when considerable leaf drop occurs.

Control

In varieties and locations where considerable leaf drop has occurred, precautions against winter injury such as the use of cover crops should be taken. A more complete discussion of winter injury and its prevention is given in New York State [Geneva] Experiment Station Bulletin 625.

STRAWBERRIES

The most common diseases affecting strawberries are leaf-spot, powdery mildew, and root-rots. Yellows has also attracted considerable attention recently. In some localities the weevil has been a serious pest. The leaf-roller is generally distributed but is rarely serious in New York. Root worms and white grubs are likely to become abundant in old plantings.

STRAWBERRY WEEVIL

(*Anthonomus signatus* Say)

In recent years the strawberry weevil has been injurious only in certain areas in the Hudson Valley. The insect is a very small snout-beetle, almost black to reddish brown in color, and only about 1/10 inch in length. It hibernates in the adult stage in rubbish, especially in woodlots or hedgerows adjoining strawberry fields. The beetles appear on the strawberry plants as soon as the blossom buds put forth in the spring. The beetle deposits an egg in an unopened bud and then causes it to fall by cutting the pedicel. In this way the crop may be seriously reduced. Occasionally half or more of the buds may be destroyed.

Control

In localities where the weevil is troublesome it is not a good plan to plant strawberries next to woodlots or to tolerate hedgerows or overgrown fences nearby. Such cover offers excellent hibernating shelter for the weevils and makes it more difficult to protect the crop from their attacks.

The best results in controlling the weevil have been obtained by dusting with a poison. A mixture of 1 pound of lead or calcium arsenate and 4 pounds of hydrated lime has given good results. The first application should be made as soon as the beetles begin to cut the bud stems. The dust is ap-

plied with a hand-duster at the rate of about 15 pounds per acre. The dust is most effective if applied in the morning of a warm sunny day because the beetles are more active under such conditions. Under New York conditions one dusting is sufficient, but if the dust is removed by rain soon after being applied, a second application should be made at once to renew the covering.

RED-SPIDER

(*Tetranychus telarius* Linnaeus)

In some parts of the State, especially on Long Island, strawberries are subject to injury by heavy infestations of the common red-spider of the greenhouse. The red-spider is a very small mite but considerably larger than the cyclamen mite. It varies in color from pale greenish yellow to dark crimson red and is usually marked with two dark spots on the side of the body. The minute, elongate, transparent eggs are to be found on the under side of the leaves. Multiplication is rapid and, with favorable weather conditions, the mites often become so numerous as to seriously injure the plants before the crop is harvested.

On strawberries the most practical method of control seems to be the use of a very finely ground sulfur dust. The dust should be applied evenly with a good duster so that the sulfur will reach the mites on the under side of the leaves and not accumulate on the foliage where it might cause injury. The application should be made on a warm day when there is little wind.

CYCLAMEN MITE

(*Tarsonemus pallidus* Banks)

Strawberries are sometimes attacked by a minute whitish mite that causes the plants to appear stunted and unhealthy with the leaves curled and distorted. This condition reduces the size and quality of the crop.

No practical method has been devised for controlling the mites on plants in the field. If it is suspected that new plants are infested they may be freed of the mites by immersing them for 15 minutes in water at a temperature of 110 degrees F. They should not be treated in bundles but should be placed loose in trays before submerging them in the water. It is very important that the water be kept at a constant temperature during the treatment.

LEAF-SPOT

(Caused by *Mycosphaerella fragariae* (Schw.) Lindau)

All strawberry growers are familiar with the purple-bordered gray spots occurring commonly on strawberry leaves. This disease is serious when spots are abundant and cause scorching of the leaves or when fruit stems

are attacked. Leaf-spot has been largely eliminated as a serious disease of strawberries through the use of more resistant varieties. The Premier variety is outstanding in its freedom from injury by leaf-spot, particularly if the bed is only fruited one year.

Certain varieties are so susceptible to leaf-spot that no practical control measures are possible.

Control

The commercial practice of fruiting strawberry beds for only one year is the best practical method of control. The location of the bed in regard to good air drainage and sunshine for quick drying of the plants will reduce the danger of serious infection. If it is decided to hold beds over for a second fruiting year some benefit may be obtained by mowing and burning the foliage after picking. Some experimental data indicate that a seasonal program of 3-3-50 bordeaux mixture is effective in leaf-spot control, but the practical value of such a program for the commercial grower has not yet been demonstrated in this State.

POWDERY MILDEW

(Caused by *Sphaerotheca humuli* (Fr.) Burr.)

This disease is readily recognized by the curling upward of the leaf margins and the scorching of these leaves. Before the curling of the leaves a very slight silvery appearance on the under surface shows the presence of the mildew fungus. Conditions favoring rapid growth of the plants in early spring or in fall often result in outbreaks of mildew.

Control

Mildew is rarely serious enough to justify special control measures. Where this trouble has been serious in past years partial control may be obtained by applications of 3-3-50 bordeaux mixture. These sprays should be started before any curling of the leaves to be most effective. Sulfur dust is effective against the mildew, but the danger of serious burning is so great that sulfur cannot be safely used in this State.

STRAWBERRY LEAF-ROLLER

(*Ancylis comptana* Frölich)

In the northern States and in Canada, strawberries are subject to injury from a small greenish or brownish caterpillar which folds the two halves of the leaflet together and, feeding within the shelter so formed, causes them to turn brown and die. While this insect is generally present in the strawberry fields of New York it has been reported as causing important injury only in rare instances.

The insect hibernates both in the larval and pupal stages; the larvae in trash about the plants and the pupae in the folded leaves. The moths of the spring brood appear in May or early June and deposit their eggs on the strawberry leaves. The larvae feed for a few days openly on the upper surface of the leaf and then draw the two halves of the leaflet together. In New York there are at least two broods annually.

Control

Much can be done to hold the strawberry leaf-roller in check by spraying the plants twice with lead arsenate, 3 pounds in 100 gallons of water, making the first application just before the blossoms appear and the second after the crop has been harvested. This is intended to kill the young larvae feeding openly on the leaves before the leaves are folded. The spray will not kill the larvae in the folded leaves.

YELLOW S

(Cause unknown)

A new trouble in strawberries particularly in the Premier variety has become more prevalent in the past few years. It is recognized in early spring by the decidedly yellow color of the foliage. All plants in areas up to several feet of the rows may be affected. Premier plants are not seriously stunted and the foliage becomes green during the summer. Many other varieties are severely injured. The cause of this trouble is unknown.

Control

Precautions should be taken to avoid taking new sets from plants near the yellowed areas in the beds.

ROOT-ROTS

Many cases of stunting or death of strawberry plants are accompanied or preceded by more or less injury to the roots. Various workers have found a large number of different fungi in these injured roots and in many cases the injury was described as a *root-rot* caused by the particular fungus which was most plentiful at the time in that area. Extensive experiments carried on in this State over a period of years indicate that, although many different fungi occur in injured roots, none of them is ordinarily able to cause appreciable injury to the roots of vigorous strawberry plants. Injured plants transplanted from areas of heavy loss usually recover when given good conditions for growth. Many apparent cases of root-rot in this State during the dry summer of 1933 entirely recovered when irrigation was practiced. The strawberry plants have a shallow root system made up of

fine fibrous roots which are susceptible to injury from a large number of causes. Among the common types of injury are winter injury, drought, drowning, and chemical injury from excessive or improperly distributed fertilizers. When injury or death of roots occurs from any of these causes various fungi in the soil enter the roots. While it is possible that root injury may result in some areas from fungi capable of attacking healthy roots, such instances are rare in this State.

STRAWBERRY ROOT-WORM

(*Paria canella* Fabricius)

The beetles of the strawberry root-worm hibernate in trash on the ground about the plants. They emerge in early spring and eat out holes in the leaves of strawberry, red raspberry, and blackberry. The eggs are deposited during May and June among the fallen leaves on the ground. The grubs burrow through the ground feeding on the roots and become full-grown during July and August. They then transform to pupae and later to beetles in earthen cells in the ground. Most of the beetles emerge during August. After feeding for a time they go into hibernation.

No satisfactory method of controlling the strawberry root-worm has been devised. By practicing the one-crop system of strawberry culture the pest can be held down to a minimum and serious damage prevented.

WHITE GRUBS

White grubs are the large, thick-bodied, strongly curved, dirty, white larvae often found eating off the strawberry roots and killing the plants. They are the larvae of the large brownish May beetles, or June bugs. These beetles appear in swarms in May and June. The females enter the soil to deposit their eggs. The eggs hatch in 10 to 18 days and the grubs feed on grass or strawberry roots for the remainder of the season. The grubs pass the winter in the soil at an average depth of about 10 inches from the surface. The following spring they return to the roots and complete their growth by June or July. They then construct earthen cells in which they transform to pupae and later to beetles. The beetles, however, do not emerge from the ground until the following spring. White grubs are likely to become abundant in old grass sod or in strawberry beds that are left down for several years.

Control

It is not advisable to plant strawberries on badly infested land, or on a newly plowed grass sod without growing an intervening cultivated crop for one season; owing to the lack of other food the grubs will concentrate their feeding on the strawberry roots and soon kill the plants. Much of the loss

occasioned by white grubs can be avoided by adopting the one-crop system of strawberry culture and alternating with some crop more or less immune such as clover, beans, or peas.

When newly set plants show by their lack of vigor that a grub is attacking the roots, there is nothing to do but to dig it out and kill it. While this method is practicable in a small bed it is too laborious for a large planting.

CURRANTS AND GOOSEBERRIES

Among insects attacking currants and gooseberries, the most troublesome are the aphid, the imported currant worm, and the San José scale. The four-lined leaf-bug is more or less sporadic in its attacks. The currant stem-girdler is at present an important pest on only a few farms. Leaf-spots are common on both currants and gooseberries; powdery mildew is serious on some varieties of gooseberries.

SAN JOSÉ SCALE

(*Aspidiotus perniciosus* Comstock)

Currants are especially subject to infestation by the San José scale. It may be controlled on currants by spraying the plants while they are dormant with the same materials as are used in orchards. For light infestations, liquid lime-sulfur, 1 to 8, may be used. For heavier infestations, where the scale is encrusted on the bark, oil sprays are more effective. A 2-per cent lubricating-oil emulsion is safe and will give good results. Commercial miscible oils may be used, following the manufacturers' directions as to dilution. Spraying for scale control should be completed before the buds open in the spring, to avoid injury.

CURRANT APHIS

(*Capitophorus ribis* Linnaeus)

The currant aphid passes the winter in the egg stage on the twigs of the red currant, black currant, and gooseberry. It is an important pest only on the red currant and its varieties. The eggs hatch as the buds are opening and the young lice find their way to the underside of the first leaves. Here they soon reach maturity and begin to give birth to living young. At first all the lice are wingless, but, as the leaves become crowded, winged forms are produced which migrate to other leaves less heavily infested. Some individuals may go to some other summer host plants but enough remain on the currant so that breeding is continuous throughout the season.

Currant leaves infested by the lice become curled and distorted so that pocket-like cavities are formed on the under side. The upper side turns a

bright red, variegated with yellow and green. Heavily infested plants may lose a large percentage of the leaves on the terminal shoot; the fruit does not ripen properly and may be stained by the honey-dew secreted by the lice.

Control

The currant aphid may be effectively and economically controlled by spraying with 1 pint of nicotine sulfate and 5 pounds of soap in 100 gallons of water, or by dusting with a 3-per-cent nicotine-lime dust. The first application should be made when the first leaves to unfold have the diameter of one-half to one inch. This kills the first generation of lice before they mature and begin to produce colonies of young. If this first application is made with thoroughness and care it may not be necessary to repeat the treatment. If, however, the infestation is severe, additional applications may be necessary when the insect threatens to increase to destructive numbers. These treatments are likely to become necessary just before blossoming and about a month before picking.

The effectiveness of the treatment can be greatly increased by pruning so as to reduce the number of canes, thus keeping the bush open and not too compact and by removing all canes lying on or near the ground.

IMPORTED CURRANT WORM

(*Pteronus ribesii* Scopoli)

The adult of the currant worm is a small sawfly, about 1/3 of an inch in length, with the head and thorax more or less black and the abdomen yellowish. The eggs are deposited in rows along the principal veins on the under side of the leaves. The eggs of the first brood are laid soon after the leaves have expanded; those of the second brood in late June or early July.

At first the larvae feed in colonies of 30 or more on a leaf but they soon scatter to other parts of the plant. When numerous they are able to strip a bush of its leaves in a few days.

It is unsafe to spray currants with an arsenical because of the residue left on the fruit and fruit stems. Sometimes currants acquire an excess of residue from the drip from overhanging apple trees even when the currants are not sprayed directly. Currant worms are very sensitive to rotenone insecticides and can be killed by dusts containing one-half of one per cent of this material. The dust should be applied as soon as the larvae hatch and begin feeding on the leaves. The dusting will be more effective if done under good weather conditions.

LEAF-SPOTS

(Caused by *Mycosphaerella grosulariae* (Fr.) Lindau, and *Pseudopeziza ribis* Klebahn)

Mycosphaerella leaf-spot is common in the State and often causes defoliation of red and white currants and gooseberries. A very similar leaf-spot caused by the fungus *Pseudopeziza ribis* may occasionally occur but is not serious. Defoliation caused by these diseases is more serious when it occurs before the crop is ripe.

Control

Although leaf-spots may cause considerable loss, local experience will determine whether spraying for their control is necessary. It is advisable for most growers to use lime-sulfur 1-40 or 4-4-50 bordeaux mixture as the carrier for the nicotine in the aphid spray. In varieties and locations where leaf-spots have been serious, as many as five sprays at two-weeks intervals may be required to prevent defoliation. Either lime-sulfur or bordeaux mixture may be used.

FOUR-LINED LEAF-BUG

(*Poecilocapsus lineatus* Fabricius)

The adult four-lined leaf-bug is about one-third of an inch in length; the general color of the body is bright orange-yellow marked with four black stripes. The newly hatched nymphs are only about one-twentieth of an inch in length and bright vermilion red in color with large black spots on the thorax. The full-grown nymph is bright orange-yellow with black wing pads and a green stripe along the edge of the body. Both nymphs and adults attack the leaves of currants and gooseberries, puncturing the tissue and sucking out the juices. The injured areas turn brown and die, giving the leaf a spotted appearance. Severely injured leaves curl up and die; the growth of the shoot is checked and the tip may die.

The eggs of the four-lined leaf-bug are laid in late June and in early July in the soft, tender, new growth; they do not hatch until about the middle of May the following spring. It takes about a month for the nymphs to reach maturity. The greater part of the damage is done during June and in early July.

Control

The nymphs can be destroyed by careful and thorough spraying with 1 pint of nicotine sulfate and 4 pounds of soap in 100 gallons of water or by dusting, during the heat of the day when there is little wind, with a 4-percent nicotine-lime dust.

CURRENT-STEM GIRDLER*(Janus integer Norton)*

The currant-stem girdler has been injurious in only a few plantings in New York State, principally in Chautauqua County. The adult is a sawfly about one-half of an inch in length; the body is black, the legs brownish yellow, the abdomen more or less yellowish. The adults appear the latter part of May. The female punctures one of the new canes a few inches from the tip and deposits an egg in the pith. She then girdles the cane about an inch above the egg, causing the tip to die and fall off. On hatching, the grub burrows downward in the pith for about six inches before becoming mature. It then forms a cocoon in the burrow, within which it passes the winter in the larval condition. It pupates in the spring and the adults emerge in May. There is only one generation a year.

This pest can be effectively controlled by cutting off and destroying the infested canes. If this work is performed in May, only two or three inches of the tip need be removed. Later after the larvae have worked down in the pith it is necessary to remove about eight inches of the cane.

POWDERY MILDEW*(Caused by Sphaerotheca mors-uvae (Schw.) B. and C.)*

This disease may be recognized by the white powdery appearance of the young unfolding leaves. European varieties are much more seriously stunted by mildew than are American varieties.

Control

In varieties and locations where mildew is serious, applications of lime-sulfur 1-40 should be started as growth begins and continued at two-weeks intervals for as many as five applications. Certain English varieties may be injured by applications of lime-sulfur. On such varieties the use of a wettable sulfur spray or a sulfur dust is suggested.

GRAPES

The principal diseases affecting grapes in New York are black rot, and powdery and downy mildew. Black rot occurs rather generally throughout the State. Powdery mildew is common in western New York and may appear in other areas, while downy mildew is prevalent only in the Finger Lakes region.

The grape leaf-hopper is widely distributed throughout the State. The berry-moth has been most troublesome in the Lake Erie region and the root-worm has, so far, been confined as a pest to that section. The rose chafer is destructive only in sandy regions.

POWDERY MILDEW

(Caused by *Uncinula necator* (Schw.) Burr.)

This disease is often destructive in the western New York grape belt and is occasionally serious in other parts of the State. The first spots of mildew appear on the green parts of the vine in early or mid-July. Soon some leaves are covered with the fungus and then it attacks the fruit clusters, spreading rapidly on the stalks and berry stems. By harvest these stems are withered and brown, the berries are dwarfed, and many of them covered with a thin white film of mildew. Probably the most serious loss is caused by the shelling of the berries on affected clusters both in the vineyard and in transportation.

Control

Sulfur dust is effective against powdery mildew but causes severe injury to our commercial varieties such as Concord, and cannot be recommended. The experimental work indicates that homemade 4-4-50 Bordeaux mixture is the surest and safest fungicide for powdery-mildew control. It is superior to all commercial copper sprays so far tested and to copper-lime and bordeaux dusts. In the Chautauqua area two bordeaux sprays control the severest infections but in the Niagara district three may be required. The first spray is applied as the berries begin to touch, with the subsequent sprays at two-weeks intervals. The addition of resin fish-oil soap at the rate of 3 pounds in 100 gallons of the bordeaux spray or of 1½ pints of Menhaden fish oil as a spreader and sticker is desirable for the first two sprays but should be omitted in later treatments to avoid spray residue.

DOWNY MILDEW

(Caused by *Plasmopara viticola* (B. and C.) Berl. and deToni)

This disease is largely limited to the Finger Lakes region of central New York and particularly to the Keuka Lake area. It occasionally occurs in small amounts on susceptible varieties in other parts of the State. Attacks may occur at any time from the blooming period until the grapes are picked. The first signs of the disease are small greenish yellow indefinite spots on the upper surface of the leaves. These spots gradually become brown, dry, and brittle. On the lower surface of the leaves similar spots appear which are soon covered with a downy white growth. The affected berries become hardened and grayish blue in color. Later the berries turn a livid brown or red and finally shrivel into mummies. Badly diseased fruits shell easily.

Control

Sprays of 4-4-50 bordeaux mixture have been found to be as effective as the stronger mixtures previously recommended. All of the copper-lime and

bordeaux dusts tested have been found to be less effective. The most important single spray is usually one just before bloom. A second spray should be applied as soon as the blossoms are set in the Keuka area and a third spray just before the berries touch is often required and in some seasons a fourth spray may be needed about two weeks later. The addition of 3 pounds of resin fish-oil soap or $1\frac{1}{2}$ pints of Menhaden fish oil in the third spray increases the spread of the spray over the berries. Spreaders shouldn't be used in later sprays because of the danger of residue. It is not practical to attempt the control of downy mildew after it has become established in the berry clusters.

BLACK ROT

(Caused by *Guignardia Bidwellii* (E.) Viala and Ravaz)

This disease first appears on the fruit, where the berries are about half-grown, as a light area surrounded by a brownish line. The spot enlarges rapidly and becomes sunken and covered with many fine dark specks. The entire berry is soon involved and becomes a hard and shriveled mummy. Although the berries are most seriously affected the disease often appears first on the leaves in June or July in the form of reddish brown rather circular spots. The centers of these spots soon turn gray and are studded with many fine black specks, the fruiting bodies of the fungus. All green parts of the vine may be attacked.

Control

Bordeaux mixture is the old established spray mixture. Where the disease has been serious in the past apply 5-5-50 bordeaux mixture: 1, when the second or third leaf appears; 2, before bloom; 3, just after bloom; 4, about 2 weeks later; and 5, about 4 weeks after the end of bloom.

In addition to spraying, control is aided by keeping the vineyard open for good circulation of air and by spring plowing to bury the fallen mummies as far as possible.

ROSE CHAFER

(*Macrodactylus subspinosus* Fabricius)

The rose chafer is an ungainly long-legged grayish brown beetle about one-half inch in length. The beetles invade the vineyards, often in swarms, about the middle of June or about the time grapes are ready to blossom. They feed on the blossom buds or blossoms and later attack the newly set fruit and the foliage. The beetles remain in the vineyard for ten days or two weeks and then migrate to other plants then in blossom.

Fortunately the rose chafer is restricted as a pest to sandy regions. The larva of the chafer is a grub that feeds on the roots of grasses in sandy soil.

The female beetle will not enter the heavier soils for egg laying nor do the grubs thrive under such conditions. Vineyards on sandy soil should be kept free of grass. If a grass-sod has been allowed to develop under the rows and the roots are infested with larvae it should be cleaned out in the spring and the ground thoroughly cultivated in May and the first half of June to destroy as many as possible of the insects in the pupal stage. It is also well to keep as much as possible of the surrounding land in cultivated crops and to reduce to a minimum the area of waste grassland near the vineyard.

The most effective method of control for the rose chafer is to spray the vines thoroughly on the first appearance of the beetles with the following mixture:

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|------------------------------|-------------|
| Confectioners' glucose | 25 pounds |
| or cheap molasses | 2 gallons |
| Lead arsenate | 5 pounds |
| Water to make | 100 gallons |

If necessary a second application may be made four to seven days later. Since the molasses or glucose destroys the adhesiveness of the poison it is best to avoid spraying just before a rain. If a rain occurs within 24 hours after spraying it may be necessary to repeat the application to renew the poison.

GRAPE ROOT-WORM

(*Fidia viticida* Walsh)

In New York state the grape root-worm has been a pest only in the Lake Erie region. There it has caused serious losses since 1900 and is still an important problem in many vineyards.

The larvae or grubs feed on the roots of the grape vines, eating off the root fibers and cutting out furrows or channels in the larger roots and main stem under ground. This injury to the roots causes the vine to take on a sickly stunted appearance, the leaves turn yellowish and may fall prematurely leaving the fruit to wither and drop. Sometimes the vines are killed outright.

The eggs of the grape root-worm are deposited under the loose bark on the old canes and trunk of the vine by a grayish brown beetle about $\frac{1}{4}$ inch in length. These beetles appear on the vines in late June and in July where they feed on the upper surface of the foliage, eating out characteristic chain-like markings in the leaves. Egg-laying usually begins the second week of July and is at its height the last of the month but a few eggs may be laid up to the first of September.

The eggs hatch in 8 days to 2 weeks and the young grubs drop immediately to the ground. They soon work their way into the soil and begin feeding on the roots. Most of the grubs become full-grown by the last of Oc-

tober although a few do not reach maturity the first season. With the advent of cold weather in late October and November the grubs descend in the soil to a depth of ten inches to two feet. There they form earthen cells in which to pass the winter.

The following May the grubs move upward. Those that are not mature feed for a time on the vine roots. Early in June the grubs form earthen cells in the soil from 4 to 10 inches below the surface. Here, between June 10 and 15, a large percentage of the grubs transform to pupae. The pupal stage lasts from ten days to two weeks. During this period the insect is in a helpless condition; if its cell is broken open the pupa is unable to construct a new one and will perish. The pupae transform to beetles in their cells and after an interval of several days the adults emerge and begin feeding on the foliage of the vines. The first adults usually appear from June 20 to 25, but in backward seasons the emergence may be delayed until July 5. They feed for about two weeks or less on the foliage before beginning to deposit their eggs. The egg-laying period lasts for a month to six weeks.

Control

In the control of the grape root-worm two lines of attack are of value; the first is a modification of cultural practices intended to kill a large proportion of the pupae in the soil and the other aims to poison the beetles by spraying before they lay their eggs.

Destruction of the pupae. It is a common practice to plow the soil back to the vines at the last cultivation thus leaving a low ridge of earth under the row during the winter. This is usually removed in May with a horse-hoe. In vineyards where the root-worms are numerous it is a good plan to delay this horse-hoeing until a large proportion of the grubs have formed pupal cells, that is until the latter part of June. Disturbing the soil at this time will crush many of the pupae or break their cells, exposing the helpless pupae to the destructive effects of sunlight and to the attack of predaceous insects. If the hoeing is followed at once by a light harrowing to break up the lumps a larger proportion of the pupae will be killed. Under the best conditions this system will not kill all the pupae and should be supplemented by spraying if the vineyard is seriously infested.

Spraying to kill the beetles. The object of spraying is to kill the beetles before the eggs are laid. The kind of spray material to use will depend on the degree of infestation. If the beetles are not very numerous a spray application should be made within a week of the appearance of the first adults, using 3 pounds of lead arsenate in 100 gallons of 8-8-100 Bordeaux mixture. The application should be repeated 10 days later. In vineyards severely infested and where the beetles are abundant it is better to use a sweetened poison spray. The most satisfactory mixture consists of 3 pounds

of lead arsenate and 1 gallon of molasses in 100 gallons of water. This spray should be applied as soon as the beetles appear in numbers on the vines. Care should be taken not to apply the sweetened spray just before a rain; it does not adhere well to the foliage and will be largely washed off. It is best to apply this spray on warm sunny days when the beetles are most active. About a week later a second spray should be applied, using this time 3 pounds lead arsenate in 100 gallons of 8-8-100 Bordeaux mixture without any molasses or other sweetening. The object of this schedule is to kill as many of the beetles as possible with the sweetened spray and then to repel the remaining beetles or those migrating in from adjoining vineyards with the lead arsenate and Bordeaux.

To be effective against root-worm beetles the sprays must be applied at the proper time and with great thoroughness so as to cover all the foliage. Vineyards that regularly receive two applications of lead arsenate and Bordeaux mixture, as indicated, rarely become seriously infested by the root-worm. This spray is also effective in the control of powdery mildew.

GRAPE-VINE FLEA-BEETLE

(*Haltica chalybea* Illiger)

Just as the grape buds are ready to burst in the spring they are subject to attack by a small, glossy, greenish, or steel-blue beetle a little less than one-fifth of an inch in length that eats out the contents of the bud and thus destroys the future cane. Each beetle usually devours several buds and if the beetles are at all numerous the size of the crop may be seriously reduced. The beetles deposit their eggs under strips of loose bark on the old canes and the brownish, black-spotted grubs may be found during June and the first half of July feeding openly on the upper surface of the leaves. Pupation takes place in the ground. The beetles hibernate under fallen leaves and other rubbish in waste fields and in nearby woodlots. The part of the vineyard lying next to such waste land is most subject to injury. This is especially true if wild grape vines are allowed to grow there. The insect breeds undisturbed on the wild vines and the following spring the beetles move out into the vineyard.

Wild grape vines should not be allowed to grow in the immediate vicinity of the vineyard. A thorough eradication of such breeding centers often solves the problem and renders other control measures unnecessary.

If in the spring the beetles are found on the vines, handpicking is the only method that will prevent the destruction of the buds. They may be jarred into a pan containing a little kerosene oil. The work of collecting the beetles must be done in the warmer part of bright sunny days while the beetles are most active, for in cold raw weather it is hard to find them. When alarmed the beetles feign death and drop at the slightest jar. Shaking the

vines or jarring the trellis will cause them to fall, for some distance along the row. For this reason it is most satisfactory to use a small stick about the size of a lead pencil with which to dislodge the beetles and make them fall into the pan of oil held beneath.

In vineyards where the infestation is serious and the grubs are on the leaves it is a good plan to add $2\frac{1}{2}$ to 3 pounds of lead arsenate to each 100 gallons of the Bordeaux mixture applied for disease control shortly before the blossoms open.

GRAPE LEAF-HOPPER

(*Erythroneura comes* Say)

The grape leaf-hopper is present in most vineyards of the State each year but only occasionally does it become abundant enough to warrant special spraying for its control. The adult hopper is scarcely one-eighth of an inch in length, pale in color, with back and wings marked with yellow and red. The insect hibernates as an adult in the fallen leaves in woodlots and the thick grass in waste fields, along fences, hedgerows, and in swales and hollows. The hoppers emerge from hibernation about the first of May and feed on a large variety of plants, often to a large extent on bush fruits, until the grape leaves are well expanded, when they migrate to the vineyard. Here they feed almost exclusively on the under side of the leaves. Egg-laying begins about the first of June and continues for about a month. The eggs are inserted just beneath the lower epidermis of the leaf and are very difficult to see even with a lens. Hatching begins in late June and is usually practically complete by the middle of July but the exact time varies considerably with the season. The nymphs require about a month to reach maturity and, like the adults, feed on the under side of the leaves. In unusually long and warm seasons two broods may develop but usually the second brood is only partial. The greatest injury to the vines comes from the feeding of the adults and nymphs during August and September. The adults swarm over the vines, sucking the life from the leaves and smutting the fruit with their excrement. The injury to the foliage prevents the proper ripening of the fruit, which in consequence never acquires its proper color, flavor, or sweetness.

If the hoppers are present in sufficient numbers to actually threaten important injury to the crop, special measures should be taken for their control. Unless they are extremely abundant, however, spraying is not likely to be profitable. The nymphs are very sensitive to nicotine sprays. The most practical method of control consists in spraying for the destruction of the first brood of nymphs in early July, using the following material:

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|--------------------------------|--------------------|
| Bordeaux mixture (4-4-50)..... | 50 gallons |
| Nicotine sulfate..... | $\frac{1}{4}$ pint |
| Menhaden fish oil..... | $\frac{1}{2}$ pint |

The application should be made when the eggs have nearly all hatched and the insects are largely in the nymph stage. It should be remembered that the nymphs are all on the under side of the leaves where it is difficult to hit them with the spray. If the spray is directed horizontally into the vines as in ordinary grape spraying, the edge of the leaf is bent down like an umbrella and protects the hoppers from the liquid. An up-turned nozzle must be used and great care taken to hit the under side of the leaves. Where the vines are trained low, as in the Finger Lakes region, spraying with fixed nozzles does practically no good, the nicotine is wasted and the entire operation is unprofitable. Where the vines are trained higher and the new canes extend out into the row, spraying with fixed nozzles is of some value, but the best results are obtained by using an angle nozzle on a short extension rod. It is best to have two men do the spraying, one on each row. If one hose is about 15 feet long and the other about 25 feet the operators can keep out of each other's way and avoid being drenched with the spray.

If it becomes evident early in the season that the hoppers are going to be excessively abundant it will pay to defer suckering the vines till the last of June. When the suckers are broken out at that time a great number of eggs and newly hatched nymphs will be destroyed with the drying up of the leaves.

It is also a good plan to burn off the dead grass on the headlands, on gully banks, and in waste fields adjoining vineyards very early in the spring to destroy over-wintering adults.

GRAPE-BERRY MOTH

(*Polychrosis viteana* Clemens)

Although the grape-berry moth is present in small numbers in most vineyards of the State each year, destructive outbreaks have occurred only in the Chautauqua area. In some instances the infestation seems to be general throughout the region, but more often it is more or less sporadic, being confined to certain vineyards or parts of vineyards.

The grape-berry moth passes the winter in the pupal state in its cocoon. The larva forms its cocoon by cutting out a small piece of the leaf and folding it over to form a cavity which it lines with silk. The cocoon is connected with the leaf at each end by a small, uncut piece of leaf tissue. The cocoons of the first brood are all made in green leaves on the vine and usually remain in place until the moth emerges. Many of the second-brood larvae, however, do not form cocoons on leaves on the vine but descend by a silken thread to the ground where they make these structures on the fallen leaves. Many of the leaves dry out and blow away but a large number of the cocoons become loosened from the leaves and remain on the ground. The pupae in these cocoons are killed by temperatures below 10° F. If the

ground remains covered by snow during the winter the pupae are protected from the cold and an abundance of moths are likely to emerge the following spring. The insect is more likely to survive in parts of the vineyard where snow drifts form in hollows or in the lee of hedges, fences, and other obstructions.

The small purplish brown moths emerge about June 1 and deposit their thin, rounded, scale-like eggs on the stems of the blossom clusters. Some of the larvae hatch and begin feeding before the blossoms open. They make a slight web among the blossom buds. They feed on the buds, blossoms, and newly set berries. Unless the insects are extremely abundant, the work of this first brood of larvae is likely to pass unnoticed. These first-brood larvae become full-grown by July 1 and then crawl to the leaves, where they construct cocoons and pupate. A second brood of moths begins to appear during the latter half of July. These moths deposit eggs on the berries or on the stems and the larvae hatching from them feed largely in the green grapes during July and August. A larva will often leave one berry and enter a second or third, webbing them together with a few threads of silk. A partial third brood of larvae may develop in late August and September. The different broods overlap so that after midsummer all stages of the insect may be found at the same time.

Control

A large part of the losses caused by the berry moth can be avoided by adopting such measures as will prevent the formation of snow drifts in the vineyard. In some cases this will require the removal of fences or hedges or the cutting down of trees in adjoining woodlots for a distance of about 100 feet from the edge of the vineyard. Where the drifts form in hollows or in the lee of buildings that cannot be removed it would be better to take up the vineyard and use the land for some other crop.

Fall-plowing of the vineyard gives protection to the overwintering pupae and tends to increase the degree of infestation the following year. It is not a good practice to follow in regions where the berry moth is a problem.

If spraying is found necessary for the protection of the crop a special application should be made just before blossoming and again as soon as the fruit has set, using:

| | |
|-------------------------------------|-------------|
| Bordeaux mixture (4-4-50) | 100 gallons |
| Lead arsenate | 3 pounds |
| Resin fish-oil soap | 3 pounds |

A special effort should be made to place the spray on the clusters.